HPC AND DATA CENTER CONTROLS SYSTEMS GUIDELINES

Revision 2, Prepared for EEHPCWG – 10/30/14 (by Bruce Myatt)

- GUIDELINES FOR THE SELECTION, DESIGN AND OPERATIONS OF FACILITIES AND EQUIPMENT CONTROLS SYSTEMS DEDICATED TO HPC & SUPERCOMPUTING SPACES
    - Owner/user objectives and KPI's
        - Functional
        - Financial
        - Environmental/sustainable
        - Risk management
            - Graded mitigation
        - Life cycle management
    - Overall controls strategy
        - Configuration
        - Controls algorithms
        - Sequence of operations
    - Operating criteria and efficiencies
        - Energy efficient and energy management,
        - Reliable, scalable, flexible, and adaptable in design & operations
- FACILITIES & OPERATIONS MANAGEMENT
    - IT Platforms, Communications & Environment Requirements
        - HPC supercomputers & exa-scale computing
        - Enterprise data processing
        - Hyper-scale cloud computing & web services
        - Combined spaces
    - Federal Government, Site & Organizational Standards
        - Risk Management
        - Operations Management
    - Professional codes & standards
        - ASME, ASHRAE, IEEE, ANSI, others
    - Construction, Environmental and Operating Permits
    - Utility Interface and Program Support
        - Electricity & Gas Utility Rates
        - Rebate Programs & Commitments
        - On-Site Power Generation
    - DCIM database and monitoring interface
        - Software and hardware compatibility
            - Multiple platform management
            - Systems interface & translators
            - Metadata management
        - Asset & configuration management
        - Operations management
        - Predictive analytics
- MEP DESIGN BASIS
    - Facilities types
        - Shared power & cooling & waste heat with building/ campus/ community
        - Dedicated data center power, space & cooling
        - Sub stations and other integrated facilities

- Operating Strategy
  - White space loads and layout
  - Power density
  - Environmental considerations (humidity & temp)
- Power & cooling strategies & equipment
  - Cooling Distribution
    - Air Systems
      - Underfloor
      - Overhead
    - Chilled/ Warm Water Systems
      - Rear door heat exchanger
      - Conduction/ Convection
    - Liquid cooling (dialectic fluids and mineral oil)
    - Combined strategies
  - Electrical Distribution
    - AC Power
      - Low Voltage
      - Medium Voltage
    - DC Power
    - Combined strategies
  - Automation
    - Free cooling
    - Equipment VFD's
    - Power transition
    - Intelligent systems
    - Substation and integrated facilities automation
  - Monitoring, Control and Communications
    - EPMS
    - Branch Circuit Monitoring

- SELECTION & INTEGRATION OF CONTROLS SYSTEMS
  - Performance Criteria
    - Scalability
    - Integration
  - Criticality & Redundancy
    - Fault Tolerance & Single Points of Failure
      - White Space
      - Central Plant
      - SCADA
      - Other facilities
    - Redundancy
      - Communications & Connectivity
        - Hardware
        - Software
      - Master Control
      - CPU's
      - Motion Controllers & Instrumentation
        - Remote or Local
        - Switchover Time

            - MTA & I/O Modules
        - Transfer of Control
            - Device Connectivity
            - Time to Switch
            - MTBF
    - Systems Interface
        - BACNET
        - MODBUS
        - SNMP
        - OEM Equipment
        - other
    - Control System Technology
        - DDC (Direct Digital Controls)
        - PLC (Programmable Logic Controls)
        - DCS (Distributed Controls System)
    - Systems Service
        - BMS/BAS (HVAC)
        - SCADA (Power Distribution)
        - Substation & Integrated Facilities
        - EPMA & Monitoring/Communications
        - Other facilities
    - Programming Strategies
        - Individual Controller Programming
        - Master Control Programming
        - Visual Displays & Single Pane of Glass
    - Systems Architecture
        - Servers & Work Stations
            - Client
            - HMI
            - Web Server
            - Security
                - Access Levels
                - Firewalls
        - Network Communications
            - TCP/IP Protocols
            - Wireless
            - RF
            - Ethernet
- OPERATIONS & MAINTENANCE
    - Commissioning
    - Operator Training
    - MEP Equipment Operations, Maintenance & Test Programs
        - Operating Conditions
            - Normal
            - Emergency
            - Alarms & Alerts
        - Maintenance Packages
        - Test Procedures

- **Operations Outages**
  - **Planned maintenance**
  - **Unplanned recovery**
- **Operating Improvements**
  - **Technology refresh and upgrades**
  - **Change in operating criteria (temperature, humidity, power density, redundancy)**
  - **Power, space and cooling equipment upgrades**
  - **Retro-commissioning**
- **Controls Equipment & Software Maintenance**
  - **Proprietary Vendor Program**
    - **Owner access & control**
    - **Time to Respond**
  - **User Managed Program**
    - **Staff Skillsets**
    - **Change Management**
- **Operating History**
  - **Maintenance Programs**
    - **Preventative, Predictive, Corrective, and Replacement**
  - **Records Management**
    - **Document Control**
    - **Data Base Interaction and Automation**

- SEQUENCES OF OPERATION
  (Example: Sequence of operations for BMS controls in an air cooled data center space under Normal Operating Conditions)
  (by Vali Sorrell)
  - AHUs/CRAHs
    - Recommended temperature setpoint
      - Ref: ASHRAE TC 9.9 Thermal Guidelines
    - For contained environments
      - Control fan speed to maintain differential pressure setpoint between hot and cold aisles
      - Use all fans (including redundant units) at part speed to meet demand
      - Control supply air temperature to setpoint by modulating chilled water valve
      - Use 2-way chilled water valves only
    - For uncontained environments
      - Control fan speed to maintain underfloor pressure (for UAD) or duct static pressure (for OAD)
      - Control supply air temperature to setpoint by modulating chilled water valve
      - Use 2-way chilled water valves only
  - Chiller plants
    - Chillers
      - Recommended chilled water supply temperature setpoint
      - Measure load by flow meters and temperature sensors
      - Sequence of chillers

        - Restart sequence
    - Cooling towers
        - Control of fan speed
            - Determine minimum acceptable tower leaving temperature
            - Run fans to optimize chiller performance; modulate fan speeds downward only when needed to keep tower leaving temperature above minimum acceptable
            - Use as many fans and cooling tower cells as possible to meet demand
    - Pumps
        - Chilled water pumps
            - Modulate pump speeds to maintain differential pressure setpoint in the chilled water piping loop
            - Use all pumps (including redundant units) at part speed to meet demand
        - Condenser water pumps
    - Heat exchangers/economizer
        - Use integrated economizer only
    - Thermal storage
        - Determine need or time of ride-through - i.e. 5 minutes to 30 minutes?
        - Consider using an in-line system (part of chilled water piping)
- Hardware
    - Front end
        - Look and feel of interface
        - Multiple access points within network
        - Remote access?
        - Maintain archival data
        - Manage alarms, alerts, system notifications
        - Integration with other functions and systems
        - Integration with DCIM (TBD)
    - Controllers
        - Redundant controllers, where appropriate
        - Dedicated controller for large equipment (e.g. cooling towers, AHUs, etc.)
        - Integration with manufacturer-provided control panels (e.g. chillers)
    - Actuators
    - Dampers
    - Valves
    - Sensors
        - Temperature
            - Wireless vs. wired
            - Accuracy
        - Humidity
            - Wireless vs. wired
            - Accuracy
        - Dew point
            - Accuracy
        - Actuator/damper/valve position indicators
            - 2-position vs. continuous
- Network

    - Topology
- Commissioning